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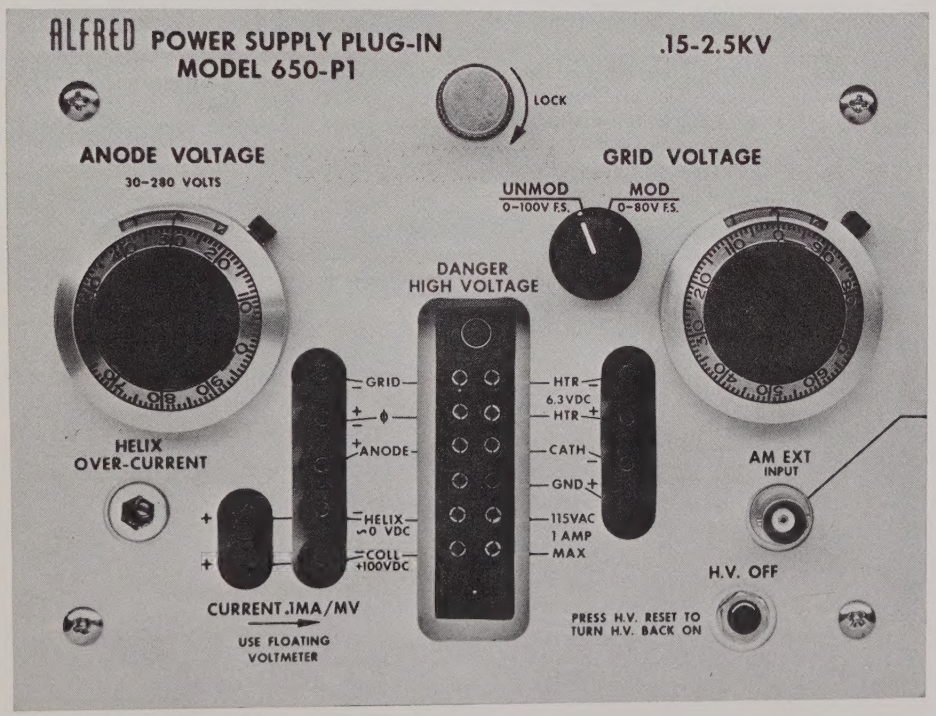
ALFRED ELECTRONICS 3176 PORTER DRIVE, PALO ALTO, CALIF.

INSTRUCTION MANUAL

MODEL 650-P1

power supply plug-in unit

S/N 17



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Manual # 650-P1

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SECTION 1

GENERAL INFORMATION

1.1 SCOPE OF MANUAL

This manual covers the ALFRED Model 650-P1 Power Supply Plug-in unit which converts any ALFRED Model 650 Sweep Oscillator into a power supply for BWO's, VTM's, some TWT's and klystron tubes, and other devices having similar power requirements. Table 1-3 of the Model 650 Instruction Manual gives the performance specifications of the Model 650-P1 Power Supply Plug-in unit.

This manual should be used as a supplement to the basic Model 650 Instruction Manual. That manual includes all necessary basic information for operating the Model 650 with any plug-in unit installed. This plug-in unit manual gives supplemental descriptive, operation, theory, and maintenance information pertinent to the Power Supply Plug-in unit.

1.2 DESCRIPTION OF POWER SUPPLY PLUG-IN UNIT

The plug-in unit is a modular assembly designed to operate with the ALFRED Model 650 to constitute a sweeping power supply. The high voltage may be electronically swept over all or any part of the range -150 to -2500 volts with respect to ground. Similarly, the high voltage may be swept about any voltage within the above range, as set by the F_0 control on the Model 650. The plug-in unit also provides heater, anode, grid, and collector supplies. The "frequency" dial plate supplied with Power Supply plug-in units is calibrated in voltage, on a logarithmic scale from -150 to -2500 volts. During swept-voltage operation, the F_0, M_1, and M_2 indicators mark three voltages by means of video markers at the markers jack for oscilloscope or plotter indication. In the single-voltage mode, five stable fixed voltages may be individually selected by means of the F_0, F_1, F_2, M_1, and M_2 controls. All plug-in units can be operated interchangeably in any Model 650, and no adjustments are required, either on the Model 650 or the plug-in unit, when interchanging plug-in units.

1.3 APPLICATIONS OF POWER SUPPLY PLUG-IN UNIT

The Model 650-P1 with the Model 650 may be used as a versatile power supply for microwave tube test and evaluation. Several Model 650-P1 units may be obtained, each with its own diode shaper board and proper grid and anode voltages preset for a specific tube. An individual test connection cable, with proper internal referencing connections for each type of tube, may also be fabricated. Thus, all that is necessary to change the test set-up from one tube type to another is to change the plug-in unit and/or the test connection cable.

The Model 650-P1 swept modes are useful for testing BWO's and VTM's. In the fixed-voltage mode, the Model 650-P1 is useful for non-swept applications, including fixed-frequency operation of some types of traveling wave tubes and klystrons.

SECTION 2

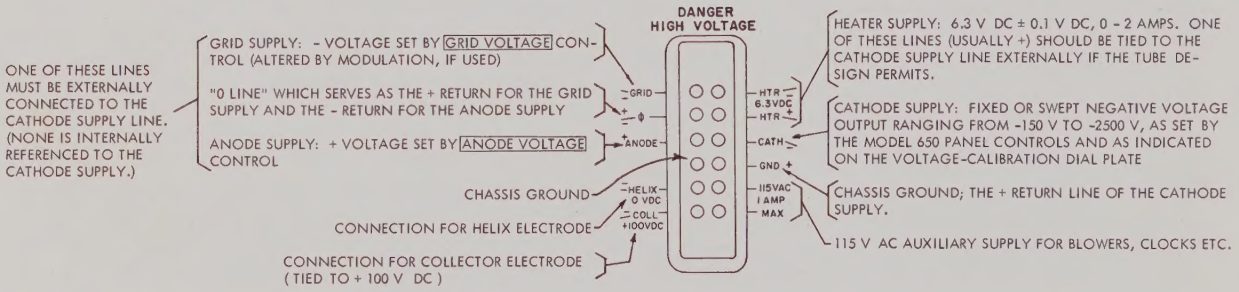
INITIAL INSTRUCTIONS

2.1 GENERAL

Refer to Section 2 of the Model 650 Instruction Manual.

CAUTION

When an rf-type plug-in unit is removed from the Model 650 to permit installation of the Model 650-P1 plug-in unit, note that the rf-type plug-in unit contains a strong permanent magnet. Make sure the rf-type plug-in unit is kept at least six inches from magnetic materials. STORE RF-TYPE PLUG-IN UNITS IN A SUITABLE SHIELDING CONTAINER, SUCH AS THE ALFRED MODEL 9000 STORAGE CONTAINER, OR ON WOOD AND AT LEAST SIX INCHES FROM MAGNETIC SOURCES.


DANGER
HIGH VOLTAGE
ONE OF THESE LINES MUST BE EXTERNALLY CONNECTED TO THE CATHODE SUPPLY LINE. (NONE IS INTERNALLY REFERENCED TO THE CATHODE SUPPLY.)
GRID SUPPLY: - VOLTAGE SET BY GRID VOLTAGE CONTROL (ALTERED BY MODULATION, IF USED)
"0 LINE" WHICH SERVES AS THE + RETURN FOR THE GRID SUPPLY AND THE - RETURN FOR THE ANODE SUPPLY
ANODE SUPPLY: + VOLTAGE SET BY ANODE VOLTAGE CONTROL
CHASSIS GROUND
CONNECTION FOR HELIX ELECTRODE
CONNECTION FOR COLLECTOR ELECTRODE (TIED TO + 100 V DC)
GRID
ANODE
HELIX 0 VDC
COLL +100VDC
HTR 6.3VDC
HTR
CATH
GND
115VAC 1 AMP MAX
HEATER SUPPLY: 6.3 V DC ± 0.1 V DC, 0 - 2 AMPS. ONE OF THESE LINES (USUALLY +) SHOULD BE TIED TO THE CATHODE SUPPLY LINE EXTERNALLY IF THE TUBE DESIGN PERMITS.
CATHODE SUPPLY: FIXED OR SWEPT NEGATIVE VOLTAGE OUTPUT RANGING FROM -150 V TO -2500 V, AS SET BY THE MODEL 650 PANEL CONTROLS AND AS INDICATED ON THE VOLTAGE-CALIBRATION DIAL PLATE
CHASSIS GROUND; THE + RETURN LINE OF THE CATHODE SUPPLY.
115 V AC AUXILIARY SUPPLY FOR BLOWERS, CLOCKS ETC.

* ANY ONE OF THESE THREE LINES MAY BE TIED TO THE CATHODE SUPPLY, AS DESIRED, TO OBTAIN THE REQUIRED ELECTRODE VOLTAGES. NORMALLY FOR BWO's, THE "0 LINE" IS CONNECTED TO THE CATHODE, SO THAT 0 TO -100 V (WITH RESPECT TO THE CATHODE) IS AVAILABLE FOR THE GRID, AND 0 to + 280 V (WITH RESPECT TO THE CATHODE) IS AVAILABLE FOR THE ANODE. FOR VTM's, WHERE THERE IS NO ELECTRODE TO BE BIASED NEGATIVELY WITH RESPECT TO THE CATHODE, THE "GRID" LINE MAY BE TIED TO THE CATHODE SUPPLY. THE "0 LINE" WILL THEN BE POSITIVE WITH RESPECT TO THE CATHODE, BY THE VOLTAGE SET ON THE GRID VOLTAGE CONTROL, AND THE POSITIVE LEVEL OF THE ANODE SUPPLY, WITH RESPECT TO THE CATHODE, WILL BE INCREASED ABOVE THE ANODE VOLTAGE CONTROL SETTING BY THAT AMOUNT. THIS PERMITS A + OUTPUT OF UP TO 380 V, AS REQUIRED BY THE INJECTOR ELECTRODE OF SOME VTM TUBES. THE REFERENCE CONNECTION CAN BEST BE MADE IN THE MATING CONNECTOR USED TO CONNECT THE CABLE TO THE TUBE BEING DRIVEN.

FIGURE 3-1. MODEL 650-P1 POWER SUPPLY OUTPUT CONNECTIONS

SECTION 3

OPERATING INSTRUCTIONS

3.1 REMOVAL, INSTALLATION, AND INTERCHANGING OF PLUG-IN UNITS IN THE MODEL 650

3.1.1 REMOVAL OF A PLUG-IN UNIT FROM THE MODEL 650. To remove a plug-in unit from the Model 650, release its panel LOCK knob by turning fully CCW, and then pull the unit out of the Model 650 by pulling on the LOCK knob. Remove the frequency* dial plate for that plug-in unit from the Model 650 panel and attach to the underside of the storage compartment door in the top of the plug-in unit, using the knurled screws removed with the plate. (See Figure 2-1 of the Model 650 Instruction Manual.)

3.1.2 INSTALLATION OF A PLUG-IN UNIT IN THE MODEL 650. To install a plug-in unit in the Model 650, first remove the frequency* dial plate from the storage compartment door of that plug-in unit and install it into the calibrated position on the Model 650 panel. (See Paragraph 2.6 and Figures 2-1 and 3-1 of the Model 650 Instruction Manual.) Make sure the plug-in unit LOCK knob is turned fully CCW so the lock arm will clear the Model 650 panel opening and will enter far enough to actuate the safety interlock switch. Then insert the plug-in unit through the Model 650 panel and lock in position by turning the LOCK knob fully CW.

3.1.3 INTERCHANGING PLUG-IN UNITS IN THE MODEL 650. To interchange plug-in units, follow the procedure of paragraphs 3.1.1 and 3.1.2 above. The Model 650 is properly calibrated for operation with the new plug-in unit by installation of the frequency* dial plate for that unit. No adjustments are required.

3.2 FUNCTIONS OF PANEL CONTROLS, INDICATORS, AND CONNECTORS.

See Tables 3-1 and 3-2 of the Model 650 Instruction Manual for basic information about these items on the main Model 650 chassis. Note that when operating with the Model 650-P1 plug-in, the F_1, F_2, F_0, M_1, and M_2 controls set voltage points, rather than frequency points, in accordance with the indicator positions on the voltage dial. Also the FREQUENCY Mode Selector switch selects swept or fixed voltage output modes, and its OFF position does not affect any voltage output except the grid bias, which is stepped to the maximum setting in the FREQUENCY-OFF mode if the UNMOD-MOD switch on the plug-in unit is in the MOD position. The SINGLE Frequency Selector switch selects a particular fixed-voltage output corresponding to the dial setting of the control selected, when the FREQUENCY Mode Selector is set to SINGLE. When the Model 650-P1 plug-in unit is used, no internal markers are available. External markers are available at the MARKER OUTPUT jack when the MARKER AMPLITUDE control is turned to the switched EXT position. If desired, these can be combined with an oscilloscope display of the operation of the tube being powered, by use of a BNC tee on the vertical input connection on the oscilloscope. If modulation is desired, it can be selected by the MODULATION Selector Switch. The modulation will appear on the grid voltage output when the UNMOD-MOD switch on the 650-P1 is in the MOD position.

Functions of controls and terminals on the Power Supply Plug-in unit are listed in Table 3-1 below.

Table 3-1. Functions of Model 650-P1 Controls and Terminals

Control or Terminal	Function
ANODE VOLTAGE Multi-turn potentiometer	Adjusts the + anode voltage output, with respect to the 0 line, over a range of 30 - 280 volts. The dial scale indicates the voltage directly, with the window digit indicating 100's of volts and the knob scale reading directly in volts.
GRID VOLTAGE 10-turn potentiometer	Adjusts the - grid voltage output, with respect to the 0 line, over a range of 0 - 100 V or 0 - 80 V, depending upon the setting of the UNMOD-MOD switch. The dial scale indicates the voltage directly when the 0 - 100 V range is chosen by selecting the UNMOD mode. The window digit then indicates 10's of volts and the knob scale reads in 100's of millivolts (i.e., 0.1 x the knob scale = volts). When the MOD mode is selected, the dial scale readings must be multiplied by a reducing factor of 0.8 to obtain the approximate voltage.
UNMOD - MOD Selector switch	Selects the grid voltage output mode: either unmodulated or modulated. In the unmodulated mode, the grid voltage remains constant at the value set by the GRID VOLTAGE 10-turn potentiometer. In the modulated mode, with the Model 650 MODULATION control in SQ WAVE, the grid voltage is driven between 0V and a maximum value (up to -80 V) selected by the GRID VOLTAGE 10-turn potentiometer. With the Model 650 MODULATION control set to AM EXT, the grid voltage is held at the maximum value selected by the GRID VOLTAGE 10-turn potentiometer, until a +10 V signal is applied to the AM EXT jack, at which time the grid voltage will drop to 0 with a response time of about 20 μs.

*The "frequency" dial plate for the Model 650-P1 Power Supply Plug-in unit is calibrated in voltage.

Table 3-1. Functions of Model 650-P1 Controls and Terminals (Continued)

Control or Terminal	Function
H.V. OFF Pushbutton	When pressed, trips the protection circuits to shut off the high voltage supply. After the H.V. OFF button is pressed, the only outputs supplied by the Model 650-P1 are the +100 V Collector output, the 115 V AC output, and the 6.3 V DC heater output. To restore the high voltage supply outputs, press the HIGH VOLTAGE RESET button on the Model 650 panel.
HELIX OVER-CURRENT Screwdriver-adjust control	Adjusts the helix overcurrent trip-out value over a range of about 3 ma (fully CCW) to about 40 ma (fully CW). NOTE: Cathode supply voltage will drop if current drain exceeds 25 ma.
DANGER HIGH VOLTAGE Connector	Permits convenient connection of all required voltages to a remote microwave tube by connecting a cable to the mating connector supplied with the Model 650-P1. Additional mating connectors can be obtained to allow interchangeable connection of several tubes with individual cables. Voltages supplied are in accordance with the panel identification, as shown in Figure 3-1.
Auxiliary Tip Jacks (adjacent to DANGER HIGH VOLTAGE connector)	Provide an additional output connection for each of the dc voltages available at the main connector, for temporary connection or monitoring purposes.
CURRENT .1 MA/MV Tip jacks	Permit monitoring of the helix and collector currents by connecting a floating voltmeter between the proper + Tip Jack and the adjacent - HELIX or -COLL Tip Jack. The voltage is measured across a 10-ohm sensing resistor, so that the readout corresponds to 0.1 ma current per mv. A floating voltmeter must be used because none of the tip jacks is at chassis ground potential.

3.3 OPERATING PROCEDURES

3.3.1 SELECTION OF CATHODE, GRID, AND ANODE VOLTAGES. There are three adjustable voltage outputs from the Model 650-P1: the cathode, grid, and anode voltages. The cathode voltage can be set for either swept (automatic or manual) or fixed-voltage operation by using the Model 650 controls in the manner described in Paragraphs 3.5 and 3.6 of the Model 650 Instruction Manual. For operation with the 650-P1 plug-in unit, the references to "frequency" in those paragraphs should be thought of in terms of "voltage" instead. Selection of sweep time and sweep trigger modes for swept voltage output should follow the procedures of Paragraphs 3.7 and 3.8. The grid and anode voltages can be set using the ANODE VOLTAGE and GRID VOLTAGE potentiometer controls on the plug-in unit panel.

3.3.2 OUTPUT CONNECTIONS (See Figures 3-1, 3-2, and 3-3). Make output connections to the tube being driven using the mating connector furnished for the DANGER HIGH VOLTAGE panel receptacle. Always press the HV OFF button before connecting or disconnecting the connector. Note the requirement indicated in Figures 3-1 and 3-2 for referencing any one of the GRID, ϕ, or ANODE output lines to the cathode supply by an external connection, which can best be made in the mating connector. One of the heater supply lines should also be referenced to the cathode supply output line by a connection within the mating connector, if tube operating characteristics permit.

To operate several tubes in sequence, additional mating connectors for the DANGER HIGH VOLTAGE panel connector can be used. The part number of a suitable connector is a Winchester RE-12P plug with QRE-12H hood.

The panel tip jacks can be used for auxiliary output measurement connections or temporary hookup connections.

WARNING

Be careful in making all high voltage connections. Insulated cable capable of withstanding 3000 volts should be used. When making "temporary" connections to the panel tip jacks, use prods that will not slip out, to prevent dangerous short circuiting or exposure to high voltages.

3.3.3 MODULATING THE SUPPLY VOLTAGES. The cathode and grid voltages can be modulated by different means. Modulation of the cathode voltage produces FM in a BWO or VTM tube being driven, and modulation of the grid voltage produces AM in BWO and TWT tubes. FM modulation (cathode voltage modulation) can be obtained independently of the setting of the UNMOD-MOD switch on the plug-in unit and the MODULATION Mode Selector switch on the Model 650 panel. AM modulation (grid voltage modulation) can be obtained only with the UNMOD-MOD switch on the plug-in unit set to MOD, and the MODULATION Mode Selector switch on the Model 650 panel set to either SQ WAVE or AM EXT. The grid supply (am) and cathode supply (fm) modulation modes are discussed separately below.

3.3.3.1 GRID SUPPLY VOLTAGE MODULATION (FOR AM MODULATION OF BWO AND TWT TUBES). When the UNMOD-MOD switch on the plug-in unit is set to MOD, the grid voltage may be modulated to switch between 0 V and 0.8 x the voltage setting of the GRID VOLTAGE control (80 V max). Such modulation can be obtained in one of two ways: (1) by a symmetrical internal square wave supplied when the Model 650 MODULATION Mode Selector switch is in the SQ WAVE position; or (2) by an external signal stepping between 0 V and +10 V applied to the AM EXT INPUT jack on the plug-in unit when the Model 650 MODULATION Mode Selector switch is in the AM EXT position. With the GRID

VOLTAGE control set for 1.25 x the voltage that turns the tube completely off, 100% modulation is obtained with either method, so that the rf output is either full-on or off. During the off portion of the square wave, the tube is biased beyond beam cut-off, so that the ON to OFF ratio is infinite. The rise and fall time of the rf output of most tubes being modulated will be less than 1 μs between the 10% and 90% power points. The symmetry ratio between the ON and OFF portions of rf output produced by the internal square wave will be between .95 and 1.05. This modulation does not shift the cathode supply voltage or the rf output frequency, nor does it degrade the excellent stability provided in single-frequency (fixed-cathode-voltage) modes.

To obtain internal square wave modulation, turn the MODULATION Selector to SQ WAVE and adjust the red Frequency Vernier Control to its mid-range position to obtain an output modulation frequency of about 1000 cps (the standard for most detection systems that may be used to monitor the tube output). The Frequency Vernier Control permits varying the modulation frequency from about 800 to 1200 cps when turned clockwise through its range of rotation. This can be used to set the modulating frequency for optimum response with any measurement system. The stability of the square wave frequency is better than 0.2% per hour under a fairly even temperature environment.

To obtain externally-controlled modulation, turn the MODULATION Selector to AM EXT. The grid voltage output will be held at the negative value set by the GRID VOLTAGE control until a +10 V signal is applied to the AM EXT jack. (The source impedance of the jack is about 2 K shunted by 100 pf.) The +10 V signal will cause the grid voltage output to drop to 0 V with a response time of about 1 μs. The grid voltage output will shift back to the level set by the grid voltage control when the +10 V signal is removed from the AM EXT jack. This modulation method cannot be used for variable-level control between 0 V and the maximum selected voltage, because it operates switching-type (not analog) circuits.

3.3.3.2 CATHODE SUPPLY VOLTAGE MODULATION (FOR FM MODULATION OF BWO AND VTM TUBES). The Model 650 provides two modes of modulation and/or external remote control of the cathode supply voltage, to vary it from the value set by the Model 650 panel controls. Each of these modes has its own input jack and a specific application. The separate jacks are the FM INPUT front panel jack, and the REMOTE FREQ rear panel jack.

For most cathode voltage (fm) modulation applications, the FREQUENCY Mode Selector switch must be in a SWEEP position to eliminate internal ac feedback which would tend to oppose frequency variations. Single-frequency operation for application of modulation can then be obtained by leaving the sweep untriggered and/or setting ΔF to zero in the $F_0 \pm \Delta F$ swept mode.

The FM INPUT jack is used for modulating or sweeping the cathode voltage output by means of applied signal voltages. The REMOTE FREQ jack is used to permit remote adjustment or programming of the cathode voltage by means of an adjustable potentiometer or resistive network.

Procedures for operation in either of these modes are given in Paragraphs 3.11.1 and 3.11.2 of the Model 650 Instruction Manual. In those paragraphs, references to frequency should be interpreted in terms of cathode voltage output as read on the indicator dial. For computations using the formulas contained in those paragraphs, use numbers from the linear "logging" scales at the top and bottom of the dial. The non-linear voltage scale readings cannot be used in the formulas, but any desired voltage points for computations can be converted to and from the corresponding points on the linear logging scale.

3.3.4 MONITORING THE MODEL 650-P1 OUTPUTS. Procedures for monitoring the supply output voltages are given in Paragraph 5.2. To monitor helix or collector current, connect a floating voltmeter between the corresponding + and - CURRENT .1MA/MV terminals on the plug-in unit panel. The reading in millivolts, multiplied by 1/10, equals the current in milliamps.

3.3.5 ADJUSTMENT OF HELIX OVER-CURRENT PROTECTION CIRCUIT. The HELIX OVER-CURRENT screwdriver control may be adjusted to a setting which provides a margin above the actual operating current level for the tube being driven by the Model 650-P1. To do this, place the instrument in operation with the desired tube, and turn the control CCW until trip-out occurs; then back off CW about 10^0 and push the HIGH VOLTAGE RESET button to restore power for operation. The following procedure permits calibrating the control for a particular trip-out level:

a. Disconnect all loads from the Model 650-P1.

b. Push the HV OFF button.

c. Make the following control settings:

   FREQUENCY Mode Selector to SINGLE

   SINGLE Frequency Selector to F_0

   F_0 Control to 0 on the logging scale

d. Obtain a precision resistor with a KΩ value computed as follows:

$$K\,\Omega = \frac{\text{(Voltage output supplied at 0 on logging scale)}}{\text{ma trip-out level desired}}$$

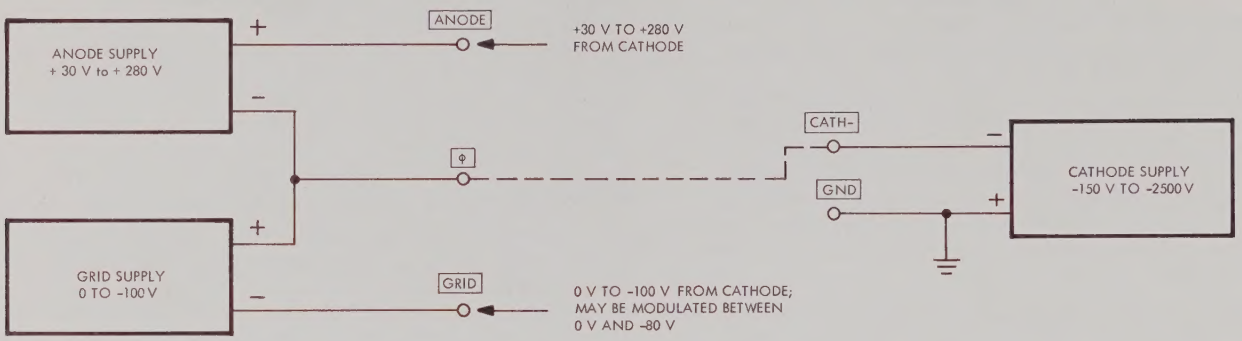
e. Connect the resistor selected in step d between the CATH - output terminal and the - HELIX terminal, using either the DANGER HIGH VOLTAGE connector or the tip jacks.

f. Turn the HELIX OVER-CURRENT control fully CW.

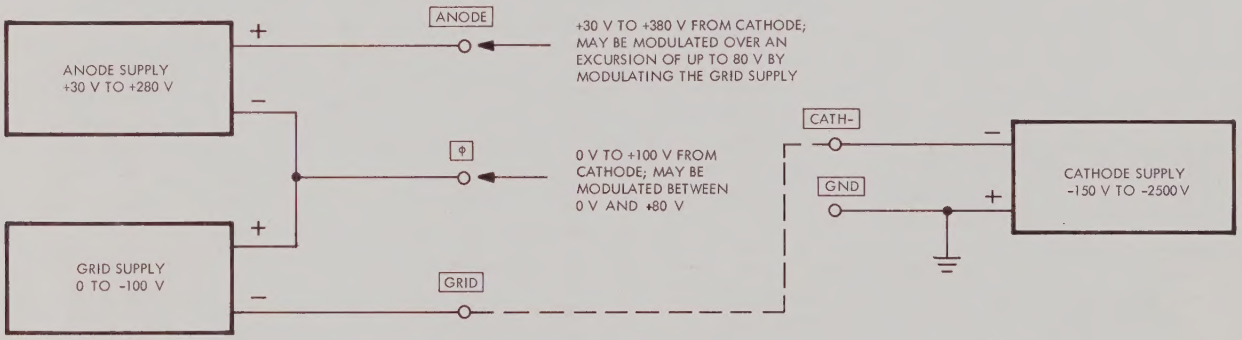
g. Push the HIGH VOLTAGE RESET button on the Model 650 panel to restore power. Turn the HELIX OVER-CURRENT control slowly CCW until the point is reached where trip-out occurs. Leave the control set at that point.

h. Remove the precision resistor installed in step e while the high voltage remains off.

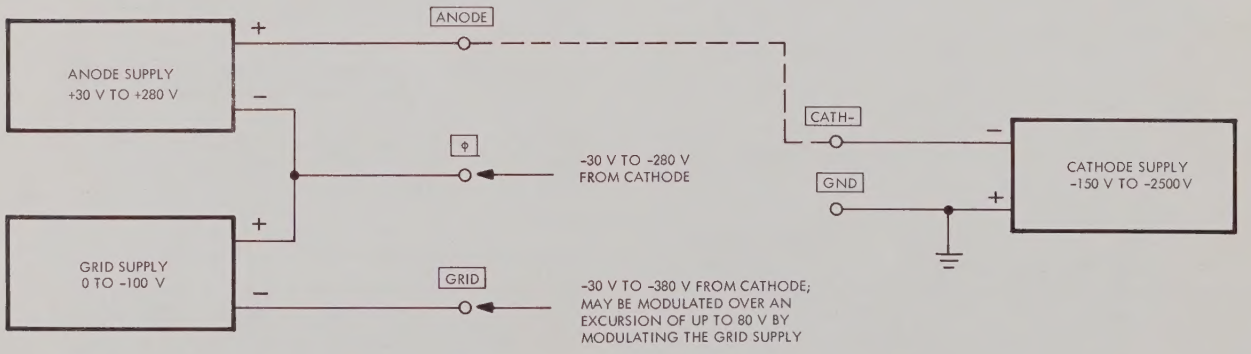
i. Press the HIGH VOLTAGE RESET button on the Model 650 panel to restore power.



A. φ LINE REFERENCED TO CATHODE (FOR BWO AND TWT TUBES)



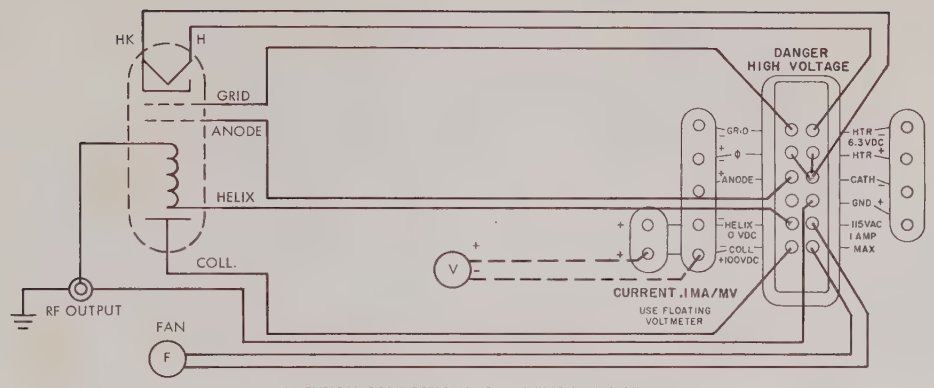
B. GRID- LINE REFERENCED TO CATHODE (FOR VTM TUBES)



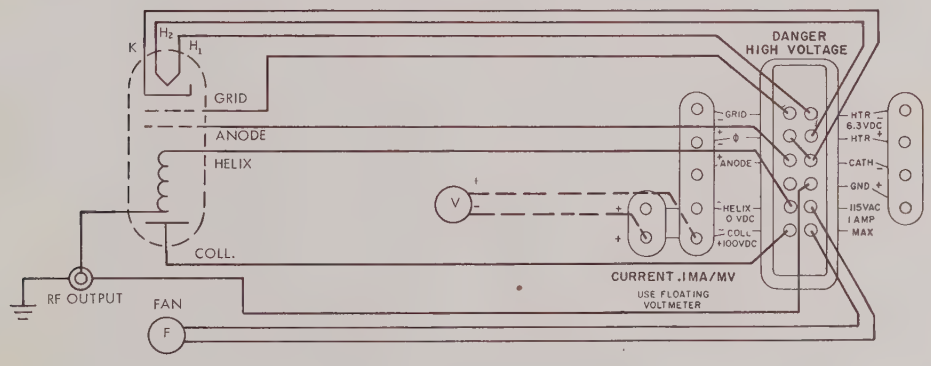
C. ANODE+ LINE REFERENCED TO CATHODE (FOR KLYSTRON TUBES)

NOTE: ONE OF THE ABOVE CONNECTIONS SHOULD BE USED AT ALL TIMES. WHEN TWO SUPPLIES ARE CONNECTED IN SERIES, THE VOLTAGES ADD AS INDICATED

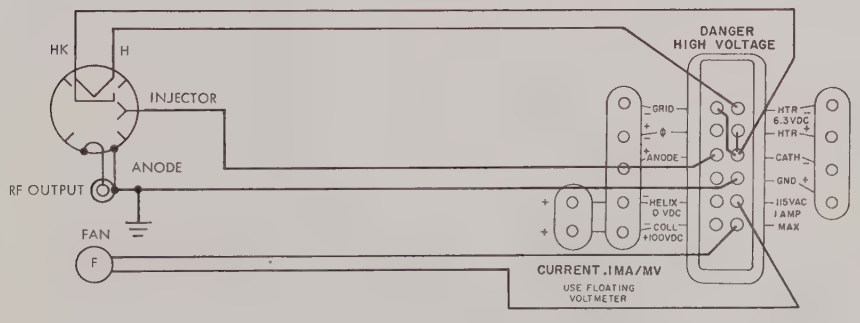
FIGURE 3-2. THREE ALTERNATE REFERENCING CONNECTIONS FOR THE HIGH VOLTAGE SUPPLIES



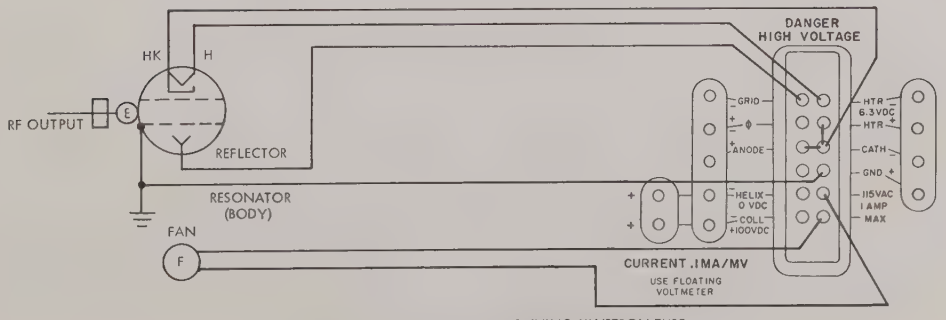
A. TYPICAL CONNECTIONS FOR DRIVING BWO TUBE



B. TYPICAL CONNECTIONS FOR DRIVING TWT TUBE



C. TYPICAL CONNECTIONS FOR DRIVING VTM TUBE



D. TYPICAL CONNECTIONS FOR DRIVING KLYSTRON TUBE
(25 MA MAX. BEAM CURRENT)

FIGURE 3-3. TYPICAL OUTPUT CONNECTIONS FOR OPERATING STANDARD MICROWAVE TUBES

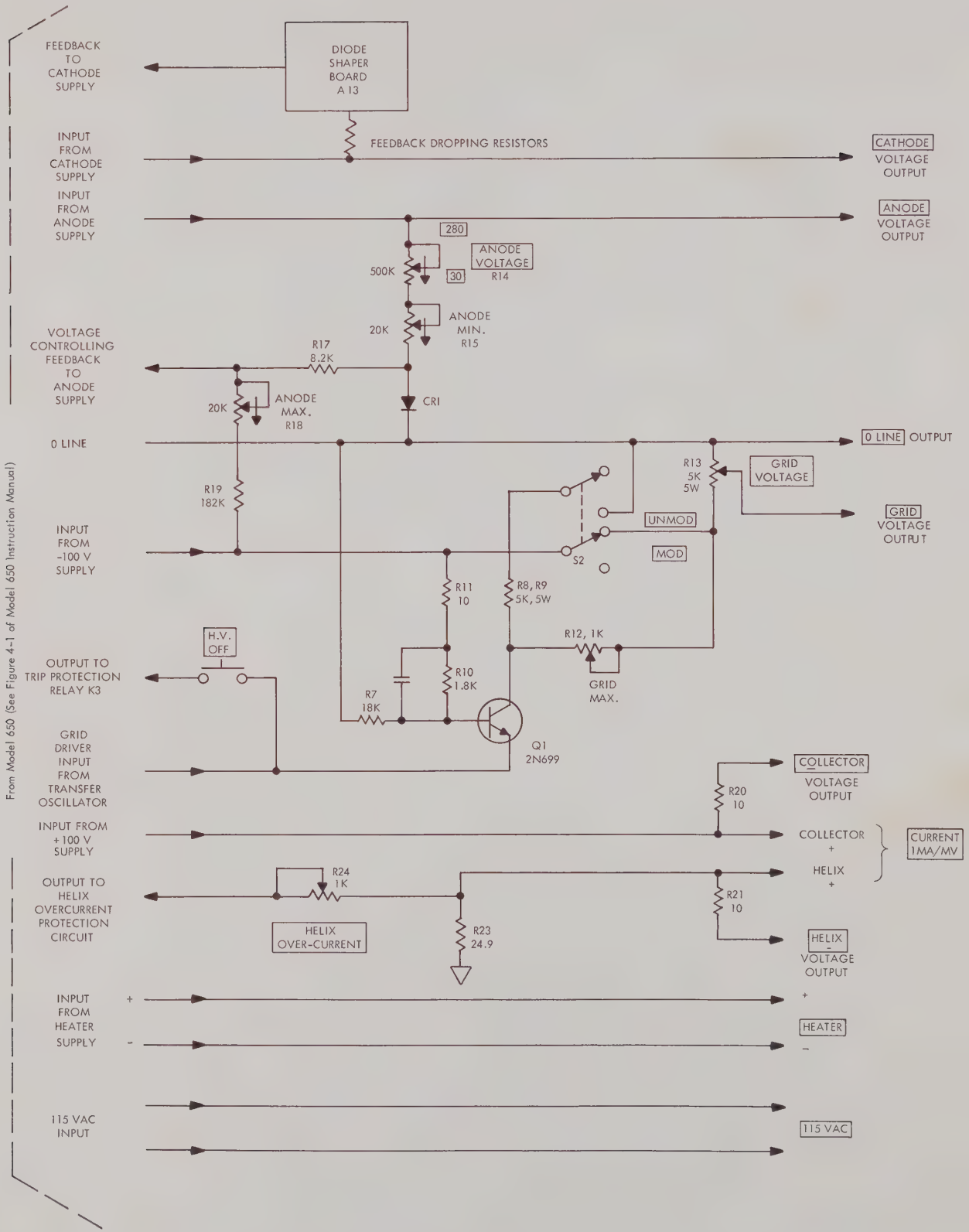


FIGURE 4-1. SIMPLIFIED SCHEMATIC OF PLUG-IN UNIT

SECTION 4

CIRCUIT DESCRIPTION

4.1 BLOCK DIAGRAM DESCRIPTION (see Figure 4-1).

A simplified schematic of the plug-in unit is shown in Figure 4-1. The Model 650-P1 plug-in unit couples out all necessary tube-driving voltages from the supplies contained in the Model 650 chassis. It also provides feedback required for control of the cathode and anode voltages. Cathode voltage is adjusted by the dial controls on the Model 650 panel, and anode voltage is adjusted by adjusting the feedback supplied by the plug-in unit. The maximum grid voltage excursion is also adjusted within the plug-in unit by means of a voltage divider which drives the output connector.

The cathode supply voltage output controls the rf output frequency of the tube being driven. The cathode supply output varies logarithmically from -150 V to -2500 V, as required to develop sufficient feedback through the Diode Shaper PC Board A13 to exactly cancel the linear 0 to +15 V voltage-determining control signal developed by the dc control circuits in the Model 650. For other voltage ranges and voltage curves which are available on special order, a different diode shaper board is used to alter the feedback to achieve the desired output characteristic.

The diode shaper board monitors the instantaneous output of the cathode supply through a string of feedback dropping resistors. These resistors drop the voltage value monitored to a range below -15 V, commensurate with the low-voltage control signals. This board then processes the low-voltage monitoring signal to develop non-linear feedback which corresponds to the logarithmic performance curve of cathode voltage-vs-dial setting. This arrangement permits logarithmic voltage output control with control signals that are a linear function of dial position.

The anode supply voltage output controls the electron beam current flow and, therefore, the maximum power output of the tube being driven. The anode supply output level is controlled by a feedback signal developed within the plug-in unit. The -100 V supply output line serves as a reference for both the anode supply and its voltage-controlling feedback circuit. The feedback signal is developed across R18 and R19, and is positive with respect to the -100 V supply line. Diode CR1 prevents the feedback signal from going more positive than the 0 line, which is 100 V above the -100 V supply line.

This feedback signal is tapped from the anode supply output line by an adjustable voltage divider string connected between the anode supply output line and the -100 V supply output line. Adjustment of the 500K ANODE VOLTAGE control R14 establishes the drop between the supply output and the feedback tap. The R14 wiper shunts a variable portion of the 500K to obtain the proper feedback level to balance out the internal reference in the anode supply when the desired output level is developed. Thus, the signal level on the feedback line varies from about 92.5 to 98 V above the -100 V supply reference line over the full range of adjustment of R14, but this is sufficient to control the anode supply over a range of 30 - 280 V.

The Anode Min. adjustment control R15 shunts a portion of the voltage divider in such a way that a clockwise adjustment reduces the current through the divider string and thereby increases the output level required to produce minimum feedback. The Anode Max. adjustment control R18 adjusts the resistance of that portion of the voltage divider across which the feedback is developed with respect to the -100 V supply line. It operates in such a way that a clockwise adjustment reduces this feedback resistance and therefore requires a higher output level to achieve cancelling feedback. Proper adjustment of these two controls calibrates R14 over its entire range.

The grid voltage output can be used to reduce the rf output level of the tube being driven for modulation or other purposes. With S2 in the UNMOD position, the -100 V supply output is connected directly across GRID VOLTAGE potentiometer R13 which operates as an output voltage divider to supply any desired level between 0V and -100 V. When S2 is in the MOD position, the output signal level across R13 is controlled by modulator transistor Q1, in response to the modulation drive signal obtained from the transfer oscillator.

For full-off modulation, a drive signal of about 35 ma is provided, producing a drop of about 85 V across R8 and R9. The resulting voltage applied to R13 is set to exactly 80 V by adjusting the Grid Max. control R12, in series with R13. R13 again operates as an output voltage divider to adjust the maximum modulation output level to any point between 0V and -80 V. For full-on modulation, zero drive is supplied by the transfer oscillator, and 0V is developed across R13.

The collector output serves as the return path for a portion of the beam current in some types of tubes. The collector output terminal is connected to the +100 V supply through a 10-ohm resistor that serves as a current pickoff between the - and + collector current measurement terminals.

The helix output serves as the return path for all or a portion of the beam current, and is operated at near-ground potential to provide a reference for the voltage levels within the tube, since the cathode supply output is operated at an adjustable negative voltage which uses the same ground return as a reference. The helix output terminal is connected to ground through a 10-ohm resistor that serves as a current pickoff between the - and + helix current measurement terminals, and through the helix overcurrent sensing resistor network. This network is a pi-connection of R23 and R24 in the plug-in unit and A7R14 in the helix overcurrent circuit in the main chassis. Trip-out occurs when 1 ma passes through A7R14. Adjustment of the HELIX OVER-CURRENT control R24 can change the distribution of current between R23 in the plug-in unit and A7R14 in the main chassis to set the total helix current required for trip-out to any value between about 3 ma and about 40 ma. (Cathode supply voltage output will drop somewhat if current exceeds the specification maximum of 25 ma.)

Note that the + anode supply and - grid supply outputs are both referenced to the 0 line. None of these three high voltage output lines is referenced to either chassis ground or

the cathode supply line within the 650-P1 plug-in unit. For proper operation, one of the three high voltage lines must be connected externally to the cathode supply output. This is a requisite not only for proper operation of the microwave tube, but also to prevent oscillation of these supplies whether or not they are actually used to drive a tube.

The H.V. OFF pushbutton, when pressed, momentarily supplies +100 V to energize self-latching protection relay K3 in the primary power circuit (Figure 4-2 of the Model 650 Instruction Manual). This relay removes power from high voltage transformer T2 until it is unlatched by pressing the HIGH VOLTAGE RESET button on the Model 650 panel.

The 6.3 V dc heater supply output voltage and the 115 V ac auxiliary power line are connected directly to the corresponding output terminals on the plug-in unit from the supplies in the Model 650.

4.2 DIODE SHAPER BOARD (see Figure 4-2). The diode shaper board provides non-linear feedback as required to produce a logarithmic cathode supply output voltage in response to control signals developed in the Model 650 that are linear with sweep time or dial position. Since the control voltage is linear with sweep time or dial position, the cancelling feedback must be developed in non-linear fashion, so that a non-linear cathode voltage-vs-frequency curve will result when the feedback is used to balance out a linear control voltage.

The diode shaper board provides this non-linear feedback by shunting away an increasing portion of the feedback current through a biased-diode ladder shunt network as the output level increases. This network is biased by a resistor string connected between + and -15 V, such that only one diode is conducting at the lowest supply voltage, and all diodes are conducting at the highest supply voltage, with a non-linear turn-on curve in between. Thus, an increase in the cathode supply voltage produces a feedback voltage increase at a slower rate (negative slope derivative) as shown in Figure 4-2B. Since the cathode supply circuit increases its voltage output until the control and feedback signals applied to its summing junction cancel, this means that a linear increase in control voltage drives the cathode supply output in non-linear fashion with a positive slope derivative, as shown in Figure 4-2B, to produce feedback cancellation.

Mathematically, the curve of required cathode supply voltage vs dial position (Figure 4-2C) approximates a third-order exponential function. By establishing a feedback curve that corresponds to the second derivative of that curve, a linear feedback voltage-vs-dial position curve is obtained at point B, since the second derivative of a third-order function is linear. For this reason, any desired voltage output curve shape can be supplied on special order, by inserting a special diode shaper board, as long as the second derivative does not change sign (i.e., the linear function is 0 or positive at all times). The feedback voltage supplied to the low-voltage diode shaper board at point A, after passing through dropping resistors R1 through R6, is a fixed fraction of the negative cathode supply output voltage. The feedback voltage developed between point A and ground is produced by the feedback current through A13R2. The ladder network, composed of diodes CR1 through CR10 and R1 through R11, achieves the feedback slope shown in Figure 4-2B by progressively shunting a greater percent of the feedback current away from R2 as the feedback level exceeds the "turn on" voltage of each biased diode.

Amplifier stages Q1 and Q2 are emitter-follower stages that serve as an impedance converter amplifier to provide a high-impedance output at point B with the same voltage as the feedback level at point A. The point B output then serves as a suitable high-impedance source for summing junction feedback current through summing resistors A1R6 and A1R38 in the cathode supply.

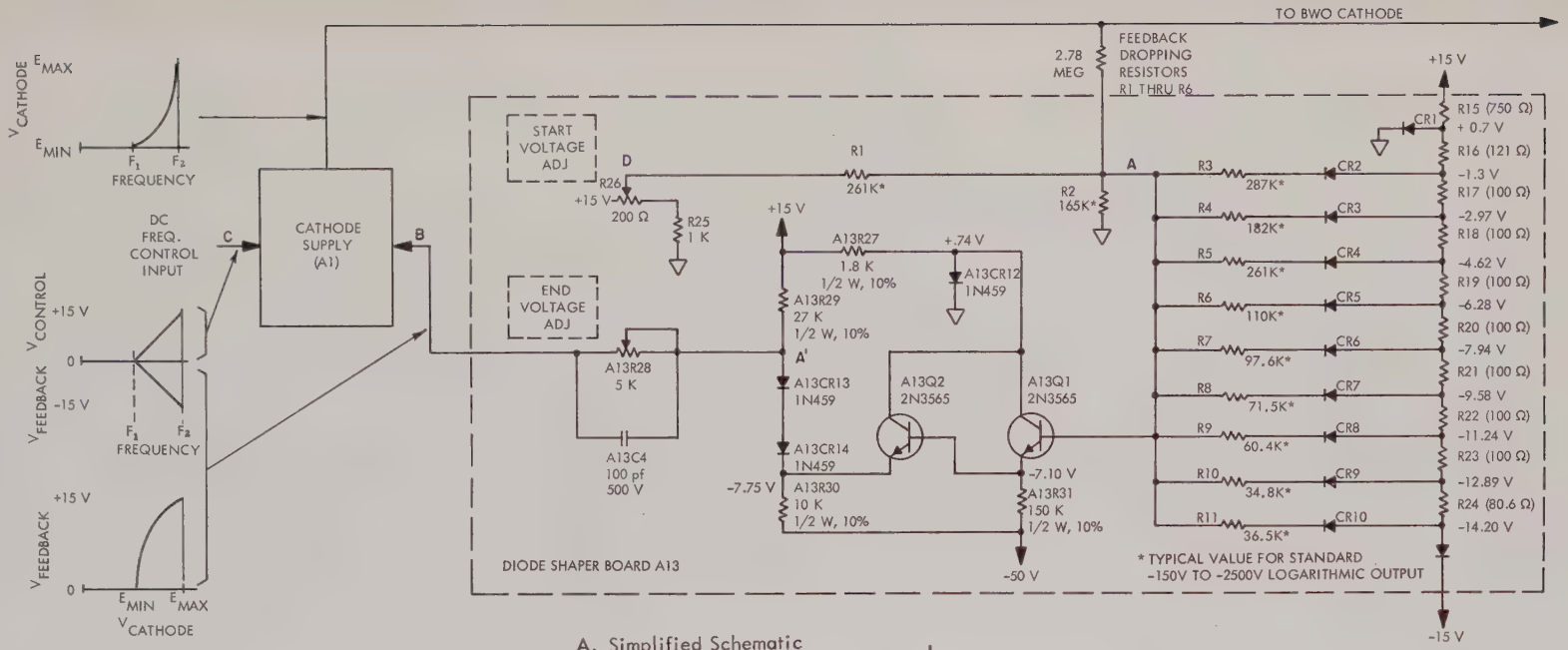
Resistors A13R15 through A13R24 and diode A13CR11 establish the bias on the diode string, and are the same value in all shaper boards. Diode A13CR1 stabilizes the voltage at the junction of R15 and R16 as the current load changes during feedback shunting conditions. Resistors A13R1 through A13R11 have the standard value shown in Figure 4-2 for standard logarithmic units, and different values are used for special-order curves. The resistor values are selected to obtain the desired curve by shunting away a greater percent of the increasing feedback current as the feedback voltage level reaches the forward-biasing point for each diode. The overall effect is that the feedback voltage developed at point A rises as cathode voltage increases, but at a slower rate, because resistors A13R3 through A13R11 shunt away part of the current that would otherwise pass through A13R2 to develop feedback voltage between point A and ground.

The resultant feedback voltage curve (Figure 4-2B) is a smooth-curve approximation with nine (9) gradual slope changes as the feedback level reaches the turn-on points of A13CR2 through A13CR10. The decrease in slope at each turn-on point is related to the additional shunting effect of the individual resistance values of A13R3 through A13R11 and the net difference between the level at point A and the return voltage of each diode.

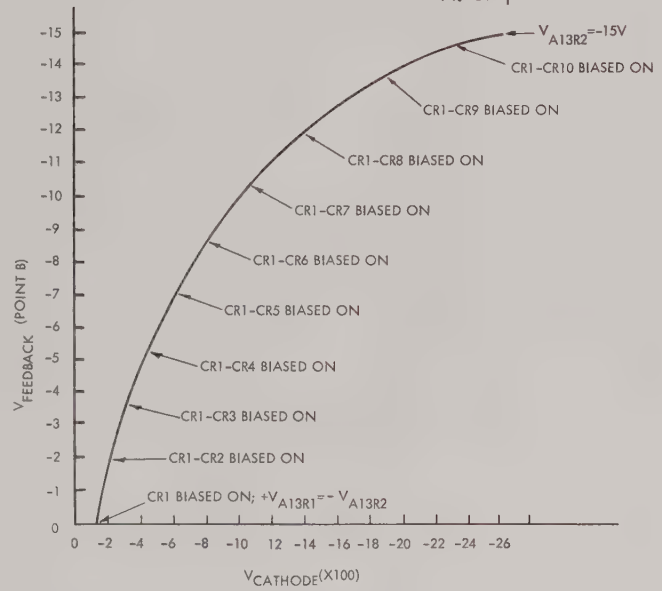
At the low band-edge output frequency, the cathode supply output voltage must have a negative value corresponding to the minimum shown on the dial, when the control voltage is zero. Thus, a zero feedback voltage must be developed at a finite supply output level, as shown by the X-axis intercept of the curve in Figure 4-2B. This is accomplished by selecting the value of A13R1 and setting its return voltage (point D) at a positive level between 12.5 and 15 V by means of Start Voltage adjustment resistor A13R26. This positive offset circuit then biases point A positively until the cathode supply voltage increases to the point where the cathode supply feedback voltage supplied to point A equals the positive offset voltage. This establishes a 0-volt null at point A, as required for zero feedback voltage. As the control voltage is subsequently increased above zero to +15 V, the feedback developed at point A increases non-linearly from 0 to -15 V.

The dc impedance converter amplifier (A13Q1 and A13Q2) consists of two cascaded emitter follower stages with the collectors held close to ground level by A13CR12. Diodes A13CR13 and A13CR14 compensate for the sum of the emitter-base drops in A13Q1 and A13Q2 when these transistors are biased to heavy conduction by a 0-level feedback signal at point A, thus developing a 0-level signal at point A'. As the feedback signal increases to the -15 V level, the conduction of A13Q1 and A13Q2 decreases so that the voltage at A' tracks that at point A, but has a higher source impedance to drive the summing junction.

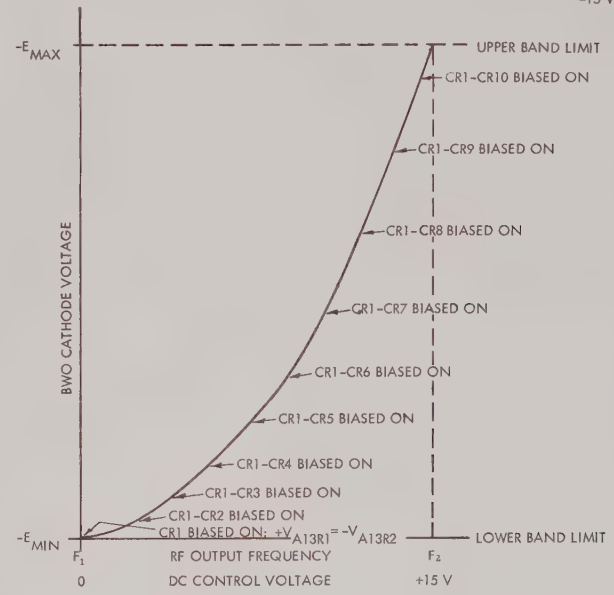
The End Voltage Adjustment resistor A13R28 provides an adjustment for the feedback current supplied from the diode shaper board to summing resistor A1R6 in the cathode supply. It can be used to adjust the overall slope of the diode shaper board curve by establishing the feedback level required to generate 1 ma feedback current to the summing junction at the upper band limit. This then sets the maximum cathode supply voltage limit corresponding to that shown on the dial.



A. Simplified Schematic


V FEEDBACK (POINT B)
V A13R2=-15V
CR1-CR10 BIASED ON
CR1-CR9 BIASED ON
CR1-CR8 BIASED ON
CR1-CR7 BIASED ON
CR1-CR6 BIASED ON
CR1-CR5 BIASED ON
CR1-CR4 BIASED ON
CR1-CR3 BIASED ON
CR1-CR2 BIASED ON
CR1 BIASED ON; +V A13R1 = - V A13R2
0 -2 -4 -6 -8 -10 12 -14 -16 -18 -20 -22 -24 -26
V CATHODE (X100)

B. Typical Diode Shaper Feedback Characteristic



C. Typical Overall Voltage vs. Frequency Characteristic for the Feedback-Controlled Cathode Supply

FIGURE 4-2. SIMPLIFIED SCHEMATIC AND OPERATING CHARACTERISTICS OF DIODE SHAPER BOARD

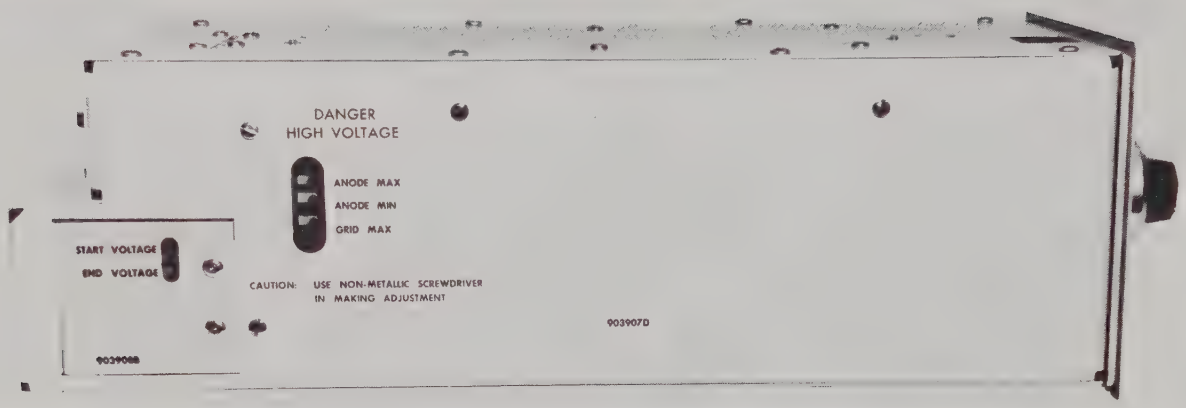


FIGURE 5-1. LEFT SIDE VIEW OF MODEL 650-P1 PLUG-IN UNIT, SHOWING ADJUSTMENTS

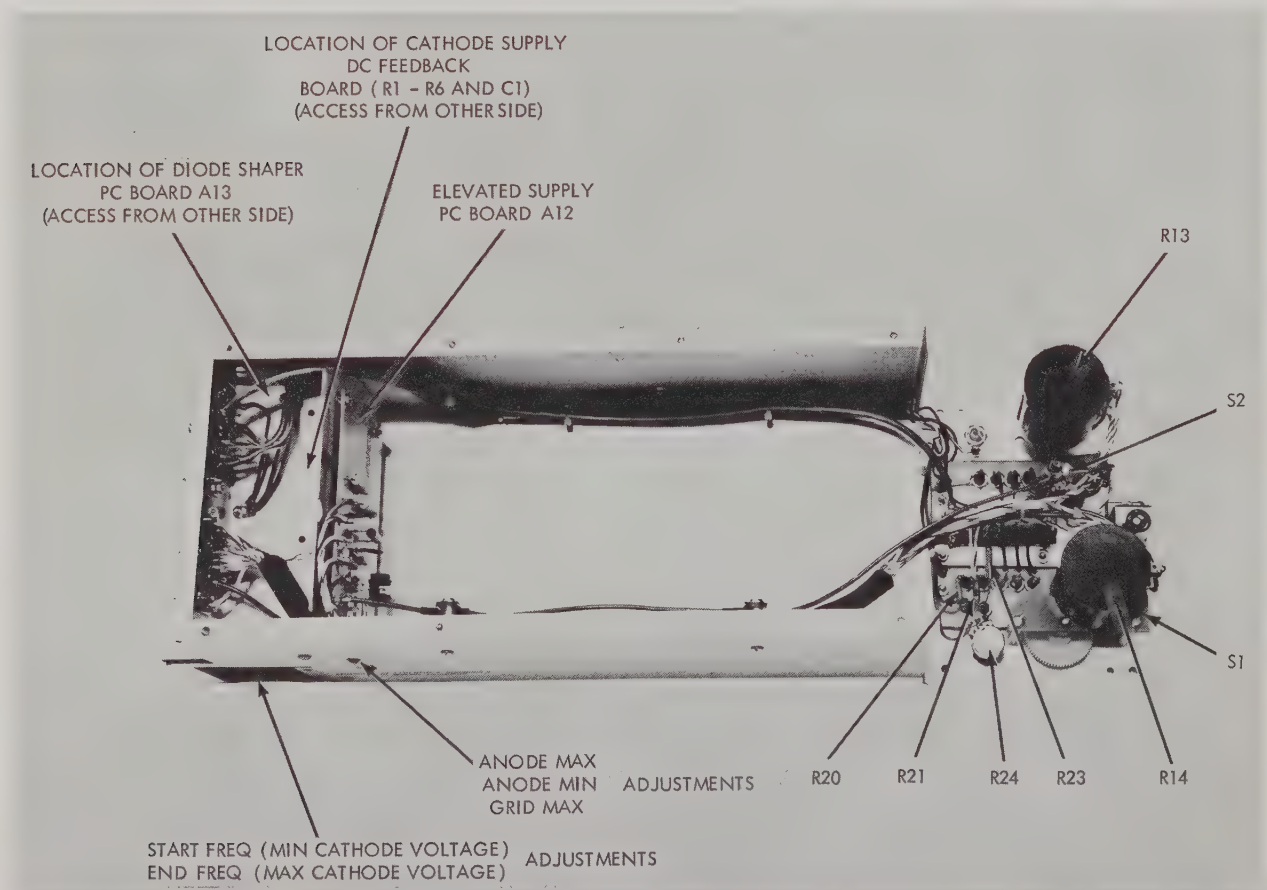


FIGURE 5-2. INTERIOR VIEW OF MODEL 650-P1 PLUG-IN UNIT, SHOWING MAJOR COMPONENTS

SECTION 5

MAINTENANCE

NOTE: Main paragraph topics in this section are numbered to agree with similar paragraphs in the Model 650 Instruction Manual, which contains material pertinent to all plug-in units. This manual contains supplementary material pertinent to the Model 650-P1 Plug-in unit.

5.1 PERIODIC MAINTENANCE

Refer to Model 650 Instruction Manual.

5.2 VOLTAGE AND CURRENT MEASUREMENTS AT CHASSIS TEST POINTS

WARNING

The supply output voltage and current pickoffs pertaining to the plug-in unit, available at test points on the front panel of the Model 650-P1, are at high-voltage levels. Suitable high-voltage measurement techniques and precautions must be used. The cathode supply output is measured with respect to chassis ground, and a high-voltage voltmeter or a high-voltage probe must be used. For measurement of grid and anode voltages, the "0 line" (TP10), which is at or near cathode potential, is the reference rather than chassis ground, and a floating voltmeter with at least 3000 volts insulation must be used. The heater supply output may be measured with high voltage off, using a standard meter. The lowest cathode supply output voltage, which in standard plug-in units is low enough (-150 V) for measurement without an insulated meter, is obtained with a Model 650 dial setting at the low end of the band in fixed-voltage operation. Other high voltage measurements should be made at this setting of the cathode supply to keep the "0 line" voltage as low as possible for safety reasons.

a. Cathode Supply Voltage. [CATH- to chassis GND +]. The proper cathode supply output voltages for the lower and upper band limits are indicated on the voltage dial scale. These limits are -150 V to -2500 V on standard units. Make the dc voltage measurement with a high voltage digital meter or suitable voltage-divider probe. Refer to item 4 of Paragraph 5.3.2 of this manual for measurement of ripple effects.

b. Heater Voltage. [HTR + to HTR -]. The proper heater supply voltage with the supply loaded with 0 to 2 amperes is 6.3 V ± 0.1 V. It is recommended that this voltage be measured with the high voltage turned off by pressing the H.V. OFF button. If the measurement is made with high voltage on, and an external connection has been made between one of the heater supply terminals and the cathode supply output line (as recommended for proper tube operation), the heater will be at cathode potential, and a floating, insulated voltmeter must be used.

c. GRID Supply [GRID - to ϕ +]. With the MOD-UN-MOD switch set at UNMOD, and the GRID VOLTAGE control set to 100, the voltage should be 100 ± 0.1 V. The measurement must be made using a floating, insulated voltmeter.

NOTE: Either the ϕ, GRID, or ANODE, output connection must be externally connected to the CATHODE supply line to avoid oscillation in those supplies. The connection must be made with high voltage off.

d. Anode Supply. [ANODE + to ϕ -]. With the ANODE VOLTAGE control set to 280, the anode supply voltage should be 280.0 V. The measurement must be made using a floating, insulated voltmeter.

e. Collector Current. [+ to - COLL]. To measure the collector current, measure the voltage drop between the + and - COLL test points. This is the voltage drop produced across a 10-ohm resistor by the collector current. Hence, the voltage measured in millivolts must be divided by 10 to obtain the current in milliamperes.

CAUTION

This voltage measurement is at the level of + 100 V, since the + COLL test point is connected to the + 100 V supply output. Thus, the voltmeter used must be floating, but need not be a high-voltage unit.

f. Helix Current. [+ to - HELIX]. To measure the helix current, measure the voltage drop between the + and - HELIX test points. This is the voltage drop produced across a 10-ohm resistance by the helix current. Hence, the voltage measured in millivolts must be divided by 10 to obtain the current in milliamperes. This voltage measurement is slightly above ground level. Thus, the voltmeter used must be floating, but need not be a high-voltage unit.

5.3 INTERNAL ADJUSTMENTS

5.3.1 AVAILABLE ADJUSTMENTS. There are five internal adjustments in the Model 650P1 plug-in unit. The instrument is designed for long-term operation with a minimum of adjustment. The adjustments provided can be used for periodic recalibration at six-month intervals or as required. The adjustments, and a recommended adjustment procedure for each, are described in the paragraph below. These procedures permit the plug-in unit to be calibrated to meet published specifications, when operating in a Model 650 main chassis which has been factory-calibrated or field-calibrated with a Sweep Oscillator Calibration Plug-in unit, Model 650T.

A factory calibration service is available at nominal cost by returning the instrument to ALFRED. Contact your nearest representative or our sales department.

NOTE: Refer to the Model 650 Instruction Manual for adjustment procedures for the heater supply voltage (A6R21 HEATER ADJ., Paragraph 5.3.3), and the -100 V supply voltage (A6R5 GRID ADJ., Paragraph 5.3.3). These adjustments are accessible from the top of the Model 650 chassis, as shown in Figure 5-1 of the Model 650 Instruction Manual.

5.3.2 ADJUSTMENT PROCEDURES. (All adjustments are shown in Figure 5-1 of this manual.)

CAUTION

Use a non-metallic screwdriver in making these adjustments.

Use of a metallic screwdriver can

Cause circuit-damaging shorts in the area between the access opening and the adjustment screw.

1. GRID MAX adjustment (R12). This adjustment calibrates the 0 to -80 V GRID VOLTAGE output when operating with the MOD-UNMOD switch in the MOD position. It does not affect the calibration of the 0 to 100 V GRID VOLTAGE output when operating in the UNMOD condition. (This basic -100 V supply level is adjusted by A6R5 on the Model 650 chassis). To set the GRID MAX adjustment, proceed as follows:

   a. With high voltage off, connect the ϕ line to the cathode supply output if such a connection is not provided in other circuitry connected to the Model 650-P1.

CAUTION

If a referencing connection between the cathode supply and either the grid or anode supply output line is present in the external circuitry, disconnect it before making the ϕ line reference connection and before attempting to perform calibration adjustments.

   b. Make the following additional control settings:

      FREQUENCY Mode Selector to SINGLE
      MOD - UNMOD switch to MOD
      GRID VOLTAGE control to 100
      MODULATION Selector switch to AM EXT

   c. Measure the voltage between the GRID - and ϕ + test jacks, using a floating, insulated meter. The voltage should be 80 V ± 0.1 V. If necessary, adjust the GRID MAX adjustment control on the plug-in unit to obtain the proper voltage.

2,3 ANODE MIN (R16) and ANODE MAX (R18) adjustments. These adjustments calibrate the 30 to 280 V ANODE VOLTAGE output. To set these adjustments, proceed as follows:

   a. Follow step a under item 1 above.

   b. Set the ANODE VOLTAGE control to 30.

   c. Measure the voltage between the ANODE + and ϕ - test jacks, using a floating, insulated meter. The voltage should be 30.0 V. If necessary, adjust the ANODE MIN adjustment control to obtain the proper voltage.

   d. Set the ANODE VOLTAGE control to 280.

   e. Measure the anode voltage output as in step c. The voltage should be 280.0 V. If necessary, adjust the ANODE MAX adjustment control to obtain the proper voltage.

   f. Since there is some interaction between the two adjustments repeat steps b through e if any adjustment was required.

   g. Adjust the ANODE VOLTAGE control to one or more mid-scale voltages and measure the corresponding output voltage. If necessary to obtain optimum mid-scale calibration, repeat steps b through f and offset the end voltages slightly in the appropriate direction to reduce mid-scale inaccuracies.

4,5 START VOLTAGE (A13R26) and END VOLTAGE (A13R28). These adjustments calibrate the limits of the cathode supply output voltage in accordance with the dial scale values.

CAUTION

Check all supply voltages except the cathode supply output before performing this calibration adjustment. (See Paragraph 5.2.)

   a. Let the instrument warm up and stabilize for about 1/2 hour.

   b. Make the following control settings:

      FREQUENCY Mode Selector to SINGLE
      SINGLE Frequency Selector to F_0
      MARKER AMPLITUDE to OFF
      MODULATION to AM OFF

   c. With the instrument operating unmodulated in fixed-voltage mode, turn the F_0 control to set the output voltages to the lower and upper dial limits in succession. Measure the cathode supply voltage output at these lower and upper band limits as directed in Paragraph 5.2 a.

   d. If either voltage measured in Step c is incorrect, adjust it to the proper value using the START VOLTAGE or END VOLTAGE adjustment controls. (The START VOLTAGE adjustment sets the voltage at the lower dial limit, and the END VOLTAGE adjustment sets the voltage at the upper dial limit.)

   e. Check the voltage tracking across the dial at several points by turning the F_0 control to different settings. Voltage accuracy should be 1% or better across the band. If necessary, steps c and d above may be repeated to offset the end frequencies slightly in order to reduce mid-band inaccuracies.

   f. To check the ripple voltage on the cathode supply [CATH- to chassis GND +], use an oscilloscope with a 10:1 divider probe and operate the vertical channel with ac coupling. The ripple voltage should not exceed ± 0.01% of the cathode supply voltage.

5.4 PARTS REPLACEMENT

5.4.1 GENERAL. The location of major components is indicated in Figure 5-2. This illustration also shows the location of those individual parts which are not identified by silkscreened reference designators on the instrument chassis or circuit boards. Parts on all PC boards are identified by silkscreened reference designators. These parts are also shown on the schematic diagram in Section 7. The proper soldering techniques for parts replacement are given in Paragraph 5.8 of the Model 650 Instruction Manual.

5.4.2 REPLACEMENT AND ADJUSTMENT OF GRID VOLTAGE POTENTIOMETER. This potentiometer is mounted to the front panel of the chassis by means of an insulated bushing. The inboard end of the insulated bushing is internally threaded to screw onto the standard panel-mount bushing of the

potentiometer. A captive insulated shaft is contained inside the bushing. The end of this shaft is designed to engage the end slot of the potentiometer shaft. Washers are placed at the potentiometer end of the insulated bushing to permit proper tightening of the bushing without causing the internal shaft to bind in the slot of the potentiometer shaft. The outboard end of the insulated bushing has an external threaded bushing which mounts on the front panel in the standard manner.

To replace the potentiometer and adjust the counting dial, use the following procedure:

a. Tag the connecting wire(s) to each of the three terminals on the potentiometer to permit positive identification for re-connection. These terminals are labeled: Slider (rear terminal with dot), CCW, and CW (front terminal).

b. Unsolder the tagged connections identified in step a.

c. Turn the counting dial fully CCW to the 0 position, and press the locking lever. Then remove the dial by loosening the attaching set screw in the side of the knob.

d. Remove the panel nut and key washer that retain the insulated bushing to the Model 650-P1 panel.

e. Lift out the defective potentiometer with the insulated bushing attached. Remove the insulated bushing by holding the bushing nut on the front of the potentiometer with a box wrench while turning the insulated bushing with an open-end wrench applied to its flatted surface at the front end. Save the washers at the potentiometer end of the insulated bushing.

f. Turn the replacement potentiometer fully CCW. Install the washers removed in step e onto the bushing of the new potentiometer. Turn the captive shaft of the insulated bushing so it will engage the slot in the potentiometer shaft. Hold the bushing shaft in this position with one hand while threading the bushing onto the potentiometer with the other hand until the shafts are engaged. This will assure that the shafts engage without axial binding. After the shafts engage, tighten the insulated bushing to the potentiometer. Check that the washers are sufficient to allow the shaft to be tightened without causing axial binding of the shafts. If not, install more washers.

g. Insert the threaded end of the insulated bushing through the panel opening, and orient the potentiometer housing so the terminals are on top. Install the key washer with the lower tang engaged in the panel opening. Then install and tighten the panel nut.

h. Attach the wire connections labeled in step a and solder in place.

i. Turn the potentiometer shaft fully CCW.

j. Place the knob and counting dial mechanism on the shaft with the window and 0 numbers at the top. (The dial should still be locked in the 0.00 position.) Tighten the attaching set screw.

k. Release the knob locking lever and turn the knob slightly CW and then back to the CCW stop to verify that the stop position is correctly set at 0.00. If the stop position is incorrect, leave the knob at the fully CCW stop, and loosen the attaching set screw. Then turn the knob until the dial reads exactly 0.00, and retighten the set screw.

5.4.3 REPLACEMENT AND ADJUSTMENT OF ANODE VOLTAGE POTENTIOMETER. This potentiometer is mounted on the rear supporting plate of a gear drive train that serves two functions: (1) Drives the potentiometer through a step-up gearing to utilize the full 10 turns from stop-to-stop while the dial turns from 0.30 to 2.80 (corresponding to 30-280 V); (2) Actuates a microswitch that shunts an output resistor in the anode supply when the voltage adjustment is set above 100 V. The knob attachment and drive train must be adjusted so that the dial readings agree with the potentiometer stops, and so that the operating cam for the microswitch operates the switch over the proper segment of the dial range.

To replace the potentiometer and adjust the counting dial and microswitch cam, use the following procedure:

a. Follow steps a and b of paragraph 5.4.2 above.

b. Turn the counting dial fully CCW to the 30 position, and press the locking lever. Then remove the dial by loosening the attaching set screw in the side of the knob.

c. Remove the three screws that retain the rear supporting plate to its standoff mounts.

d. Loosen the two set screws in the hub of the plastic gear which carries the cam, to release the potentiometer shaft from the gear train. The gear may be turned CCW as necessary for access to the set screws.

e. Slowly pull the rear supporting plate, with the potentiometer attached, away from the gear mechanism, so that the potentiometer shaft is exposed (the wiring to the microswitch will limit the movement of the plate). Do not lose the thrust washers that separate the potentiometer mounting nut from the cam gear.

f. Remove the old potentiometer from the supporting plate by removing its attaching nut.

g. Install the new potentiometer on the supporting plate using the attaching nut, and orient the potentiometer housing so the terminals are on the top. Turn the potentiometer shaft fully CW.

h. Place the thrust washers over the potentiometer shaft, and move the supporting plate back into position on the rear of the gear mechanism, placing the potentiometer shaft inside the hub of the cam gear and placing the plastic bushing of the dial shaft end gear into the support opening in the plate.

i. Turn the knob shaft, if necessary, to rotate the cam surface on the cam gear to the top center position (i.e., as close to horizontal as possible).

j. Tighten one accessible set screw on the hub of the cam gear. Then turn the dial shaft, if necessary, for access to the other set screw in the hub, and tighten it.

k. Turn the dial shaft fully CCW.

l. Place the knob and counting dial mechanism on the shaft with the window at the top. (The dial should still be locked in the 0.30 position.) Tighten the attaching set screw.

m. Release the knob locking lever and turn the knob slightly CW and then back to the CCW stop to verify that the stop position is correctly set at 0.30. If the stop position is incorrect, leave the knob at the fully CCW stop, and loosen the attaching set screw. Then turn the knob until the dial reads exactly 0.30, and retighten the set screw.

n. Turn the knob slowly CW while listening for the click of the microswitch. This click (the switching point) should take place when the dial scale reads 100 V ± 5 V. If the switching takes place outside these limits, study the cam operation to determine the direction and approximate amount of cam adjustment required to achieve proper operation. Then loosen the two set screws on the hub of the cam gear, and turn that gear the required amount in the proper direction. Retighten the set screws.

o. Repeat steps m and n and make any further adjustments necessary to achieve proper operation.

SECTION 6

PARTS LIST

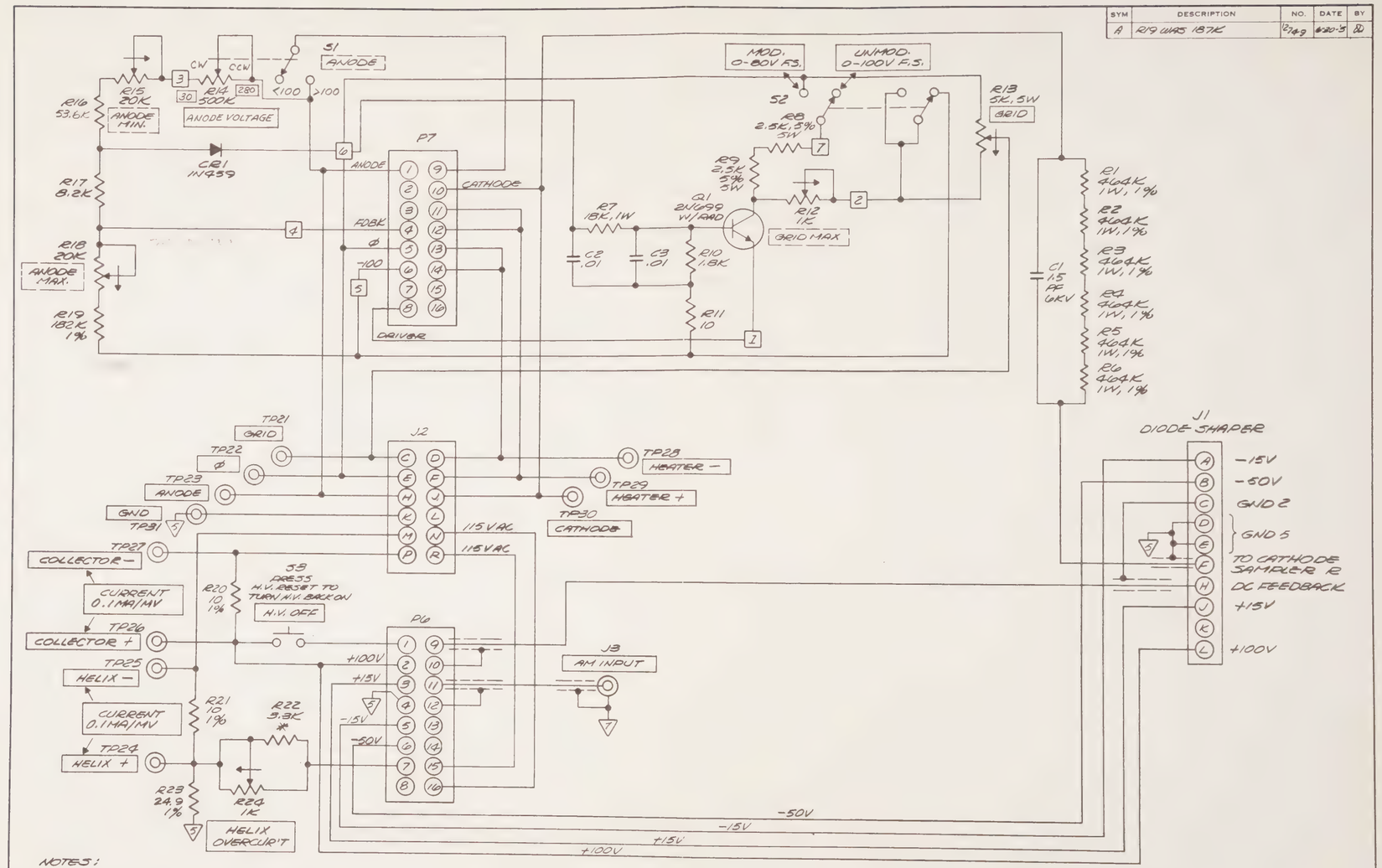
CIRCUIT REFERENCE	ALFRED PART NO.	DESCRIPTION	TOTAL QTY.
A. HIGH VOLTAGE FEEDBACK BOARD.			
C1	12-30	Capacitor, Fixed, Ceramic, 1.5 pf, 6 kv	1
R1 thru R6	52-464K	Resistor, Fixed, Metal Film, 464K, 1 w, 1%	6
B. ELEVATED SUPPLY PC BOARD (Assembly A12; Part No. 950876)			
C2 and C3	12-3	Capacitor, Fixed, Ceramic, .01 mf, 600 v	2
CR1	81-41	Diode, 1N459	15
Q1	81-72	Transistor, 2N699	1
R7	42-18K	Resistor, Fixed, Comp., 18K, 1 w, 10%	1
R8 and R9	61-13	Resistor, Fixed, WW, 2.5 K, 5 w, 5%	2
R10	41-1.8K	Resistor, Fixed, Comp., 1.8K, 1/2 w, 10%	1
R11	41-10Ω	Resistor, Fixed, Comp., 10Ω, 1/2 w, 10%	1
R12	71-105	Resistor, Variable, 1K	
R13		See Panel Assembly Parts (below)	
R14		See Panel Assembly Parts (below)	
R15	71-92	Resistor, Variable, 20 K, 20 turns	2
R16	56-53.6K	Resistor, Fixed, MF, 53.6K, 1/2 w, 1%	1
R17	41-8.2K	Resistor, Fixed, Comp., 8.2K, 1/2 w, 10%	1
R18		Same as R15	
R19	56-182K	Resistor, Fixed, MF, 182K, 1/2 w, 1%	1
C. PANEL ASSEMBLY (Part No. 950878)			
R13	74-10	Potentiometer, Helipot 5 K	1
R14	74-9	Potentiometer, Helipot 500K	1
R20 and R21	56-10Ω	Resistor, Fixed, MF, 10Ω, 1/2 w, 1%	2
R22			
R23	56-24.9Ω	Resistor, Fixed, MF, 24.9Ω, 1/2 w, 1%	1
R24	71-100	Resistor, Variable, 1 K	1
S1	101-21	Switch, snap-action lever	1
S2	913453	Switch, Modified	1
S3	101-19	Switch, Pushbutton	1
D. DIODE SHAPER PC BOARD (Assembly A13; Part No. 950872)			
A13C1 thru A13C3	12-34	Capacitor, Fixed, Ceramic, 0.1 mf, 100 v	5
A13C4	12-22	Capacitor, Fixed, Ceramic, 100 pf, 500 v	1
A13C5 and A13C6		Same as A13C1	
A13CR1 thru A13CR14		Same as CR1	
A13Q1 and A13Q2	81-115	Transistor, 2N3565	2
A13R1 thru A13R11	-	See Table 7-1 on Schematic 900713C-P1	
A13R12 thru A13R14		Not used	
A13R15	56-750Ω	Resistor, Fixed, MF, 750Ω, 1/2 w, 1%	1
A13R16	56-121Ω	Resistor, Fixed, MF, 121Ω, 1/2 w, 1%	1
A13R17 thru A13R23	56-100Ω	Resistor, Fixed, MF, 100Ω, 1/2 w, 1%	7
A13R24	56-80.6Ω	Resistor, Fixed, MF, 80.6Ω, 1/2 w, 1%	1
A13R25	56-1K	Resistor, Fixed, MF, 1K, 1/2 w, 1%	1
A13R26	71-90	Resistor, Variable, WW, 200Ω, 20 turn	1
A13R27	41-1.8K	Resistor, Fixed, Comp., 1.8K, 1/2 w, 1%	1
A13R28	71-94	Resistor, Variable, WW, 5K, 20 turn	1
A13R29	41-27K	Resistor, Fixed, Comp., 27K, 1/2 w, 10%	1
A13R30	41-10K	Resistor, Fixed, Comp., 10K, 1/2 w, 10%	1
A13R31	41-150K	Resistor, Fixed, Comp., 150K, 1/2 w, 10%	1

SECTION 7

SCHEMATIC DIAGRAMS

Schematics are included in the following order:

OVERALL CHASSIS SCHEMATIC	(900746C)
DIODE SHAPER PC BOARD A13	(900713C-P1)



SYM	DESCRIPTION	NO.	DATE	BY
A	R19 WAS 187K	21249	8-20-65	DD

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   - 1A. ALL RESISTOR IN OHMS, 1/2W, 10%
   - 1B. ALL CAPACITOR IN MICROFARADS, 500V
   - 1C. ALL RESISTOR 1% ARE METAL FILM
2. SQUARES (□) DESIGNATES TERMINAL CONNECTION ON ASSY "A12", ASSEMBLY NO. 950876

ITEM	REQD	PART NO.	DESCRIPTION

LIST OF MATERIAL

MATERIAL

MATERIAL STOCK NO.

FINISH OR TREATMENT

		DATE
DRAWN		6-4-65
ENG		9-6-65
PROD		9-20-65

SCALE

SCHEMATIC
PLUG-IN
POWER SUPPLY

DIMENSIONS ARE IN INCHES
TOL: .XX ± .015, .XXX ± .005, ANGLE ± ½°
UNLESS INDICATED OTHERWISE

SERIAL 11-UP	650-P1
NEXT ASSY	USED ON

ALFRED ELECTRONICS
PALO ALTO, CALIFORNIA

900746C

SHEET 1 OF 1

SYM	DESCRIPTION	NO.	DATE	BY
A	Q1 & Q2 REPLACED Q1A+Q1B S/N 30 & UP	12700	4-15-65	MN
B	SCHEMATIC ERROR R27 WAS SHOWN AS 1.5K	12772	7-19-66	JFC

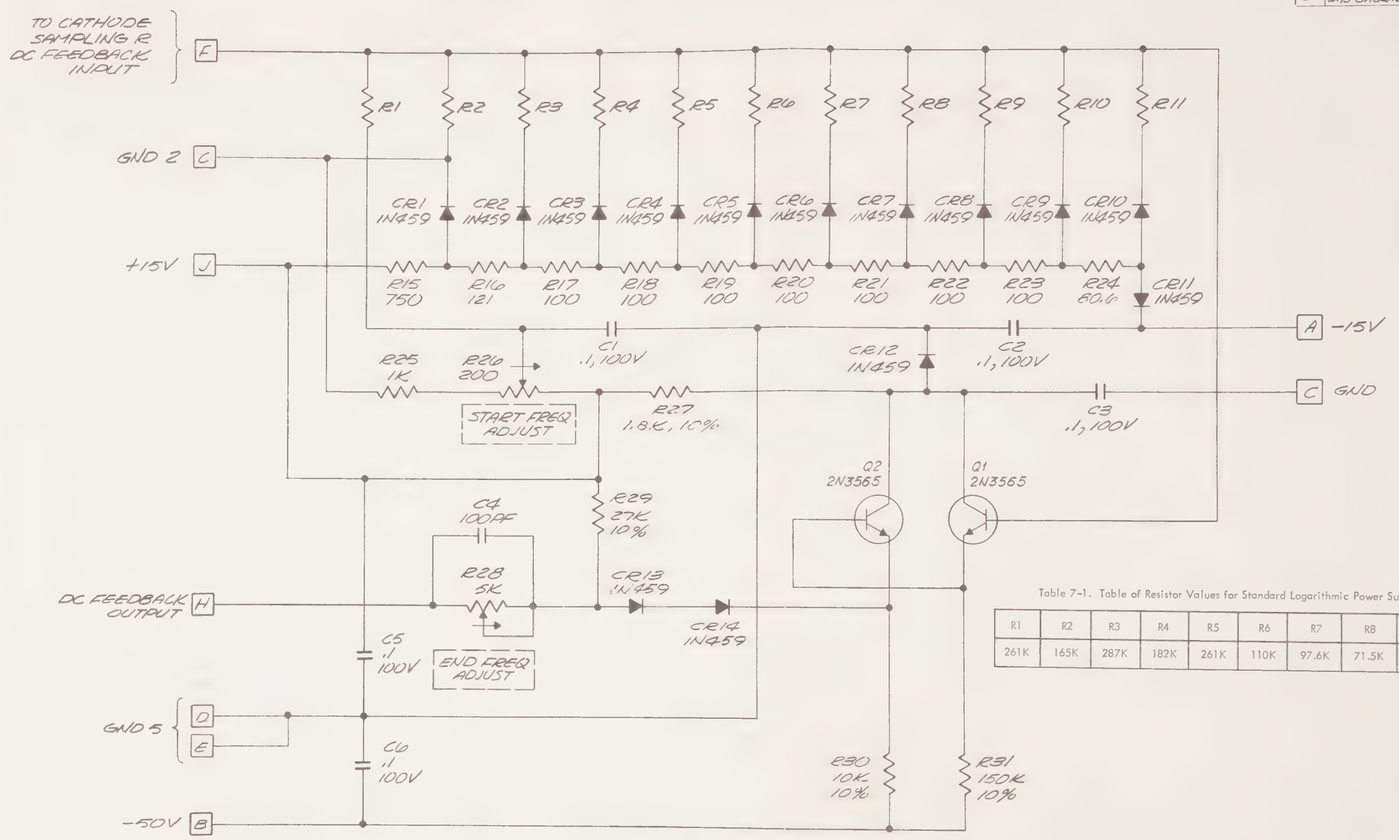


Table 7-1. Table of Resistor Values for Standard Logarithmic Power Supply Plug-in Unit

R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11
261K	165K	287K	182K	261K	110K	97.6K	71.5K	60.4K	34.8K	36.5K

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   1A. ALL RESISTORS IN OHMS, 1/2W, 1% METAL FILM
   1B. ALL CAPACITORS IN MICROFARADS
2. REFER TO INSTRUCTION MANUAL FOR SPECIFIC VALUE OF R1 THRU R11 FOR THE PARTICULAR MODEL INVOLVED
3. SQUARES (☐) DESIGNATE PRINTED CIRCUIT CONNECTION ON ASSY NO. 950---
4. PREFIX REFERENCE DESIGNATORS BY "A13" (I.E.: A13R1, A13C2)

ITEM	REQD	PART NO.	DESCRIPTION
			LIST OF MATERIAL

MATERIAL

MATERIAL STOCK NO

FINISH OR TREATMENT

DRAWN D. Stern 11/16/64
ENG. Hans Schmid 1-4-65
PROD W. Hudson 1-11-65

SCALE

SCHEMATIC
DIODE SHAPER

DIMENSIONS ARE IN INCHES
TOL: .XX ± .015, .XXX ± .005, ANGLE ± ½°
UNLESS INDICATED OTHERWISE

S/N 11-UP | 950
NEXT ASSY | USED ON

ALFRED ELECTRONICS
PALO ALTO, CALIFORNIA

900713C-P1

SHEET 1 OF 1

SHIPMENT DAMAGE CLAIM

The instrument should be tested as soon as it is received. If it fails to operate properly or is damaged in any way, a claim must be filed with the carrier. Have carrier agent inspect damage to instrument and packing crate and forward us a copy of his written report. You will then be advised of replacement or repair arrangements and disposition of the equipment. Please include model number, type number and serial number when referring to this instrument for any reason.

WARRANTY

ALFRED products are warranted against defects in workmanship and materials. This warranty is limited to repair or replacement of products or parts (except tubes, transistors, and batteries) which prove defective within one year after delivery to original purchaser. ALFRED ELECTRONICS is not liable for consequential damage.

If any fault develops:

1. Notify us, giving full details of the difficulty, including the model number, type number and serial number. Upon receipt of this information, you will be sent service instructions or shipping data.

2. Upon receipt of shipping instructions, forward the instrument prepaid and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins when instrument is not covered by this warranty.

PACKING

The instrument should be packed in the original carton. If unusable or not available, use a wooden box with approximately three inches of excelsior or other shock-absorbing material surrounding the instrument. If desired, packing services of a local transfer and storage company may be employed.

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